Space Weather Technical Forecast

Issued on Sunday, 15 October 2023 at 01:16 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1 around the start and middle of the coming UTC working week. Chance of R1 throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours, with X-ray activity at GOES16 and 18 peaking with an impulsive C9.8 flare at 14/0515UTC from AR3460, with a second smaller, long-period C3.5 produced at 14/1633UTC from AR3467. Despite being long-period and showing an accompanying coronal dimming, this second flare does not appear to have produced any Coronal Mass Ejection (CME).

There are up to six sunspot regions on the disc at present. HMI imagery for the past 24 hours has been intermittent, and lower resolution NSO GONG ground-based intensitygrams have been employed to fill data gaps. None of the current front side groups appear especially complex in available imagery, with the main discernible trend being of emergence of trailing spots in AR3466 in the northwest and a spreading tendency here.

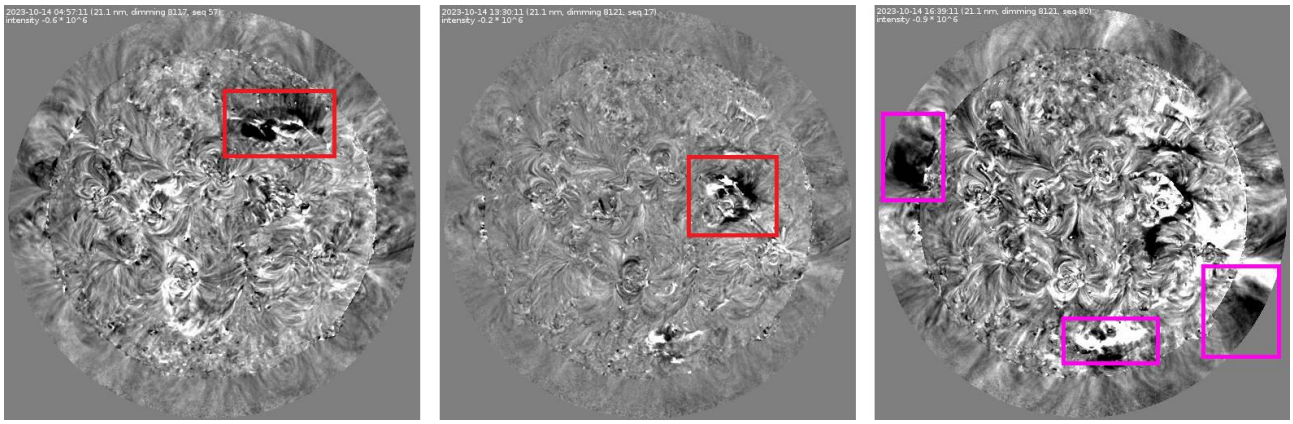

Figure 0: Main SIDC ROB time-integrated AIA 211 EUV dimmings of the past 24 hours. The two red-boxed events have been modelled as potentially having glancing incidence in the UTC day of Wednesday 18 October. The three magneta-boxed events were noted, but have either not conclusively proven to be Earth-directed, or have not demonstrably left the immediate solar environment.

There were numerous candidates for CMEs observed in the past 24 hours.

There were potentially up to three noted filament eruptions - firstly a corona-based dimming around N35W030 starting around 14/0340UTC. This was not visible in H-Alpha, but did show some filament-channel like behaviour in its aftermath in EUV. This has been modelled and results in a possible glancing blow of Earth due late in the UTC morning of Wednesday 18 October.

The second notable event was a dimming and observed filament channel in EUV from immediate

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north of AR3466 at 14/1240UTC, around N15W25. This again appeared to be anchored in the corona rather than photosphere, although there was some surrounding brightening in near-infrared (seen on H-Alpha). This CME may add to or very closely follow the above glance in the UTC morning of Wednesday 18 October.

The third event was a low solar latitude disappearing filament, seen as being mobile on El Teide H-Alpha around 14/1400UTC. The resulting ejecta is not obviously apparent on coronagraph imagery, with a larger southwest limb CME at 14/1630UTC possibly swamping any ejecta and dominating imagery. Provisionally the filament is considered too low latitude to feature at Earth, and the polluting southwest limb event is likely too far west, although both will be fully assessed in due course.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, suggest erratic ongoing connection to the fast wind from CH58/-, with the phi angle accordingly mainly negative (towards the Sun), but with numerous short-lived forays into positive territory.

The solar wind speed showed early Elevated peaks of around 525km/s, with a general declining trend observed thereafter into Slightly Elevated levels and 475km/s. The solar wind density was at background levels and often near the lower limit of measurement capability. The IMF was at or below 6nT, with the north-south component ranging between +5 and -2nT, i.e. displaying a slight co-aligned bias with Earth's field.

The net result of the above solar wind measures was for provisionally Quiet to Unsettled geomagnetic activity, peaking in the 09-12UTC interval with a Kp of '3-'.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background levels.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels, peaking in the UTC evening of 14 October around 100pfu. Associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold. The observation at 15/0001UTC was 1.18e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a slightly rising Chance of M-class flares at first in the four-day period as a result of potential returning regions, with the risk likely to have plateaued into the new UTC working week. The risk then moderates slightly midweek with the departure of AR3460.

Solar Wind / Geomagnetic Activity: The current fast wind from CH58/- should wane through the remainder of the current UTC weekend, with a decreasing likelihood of further Unsettled intervals. CH60/+ should then arrive later in the UTC day of Monday 16 October, bringing a Chance of G1. Up to two CMEs then feature in the forecast, both low confidence and both glances, but potentially crossing 1AU later in the UTC morning of Wednesday 18 October, and giving a further Chance of G1, probably with a preceding lull in activity as the CH60 fast wind matures.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux will most likely remain at Background levels.

High energy electron flux (greater than 2MeV) forecast is expected to be at background to moderate levels on day 1 (14 Oct), with a slight chance of reaching the High threshold from day 2 (15 Oct) as the effects of the fast wind from CH58 wane. Fluence is expected to follow a similar trend but should remain below the Active threshold throughout.

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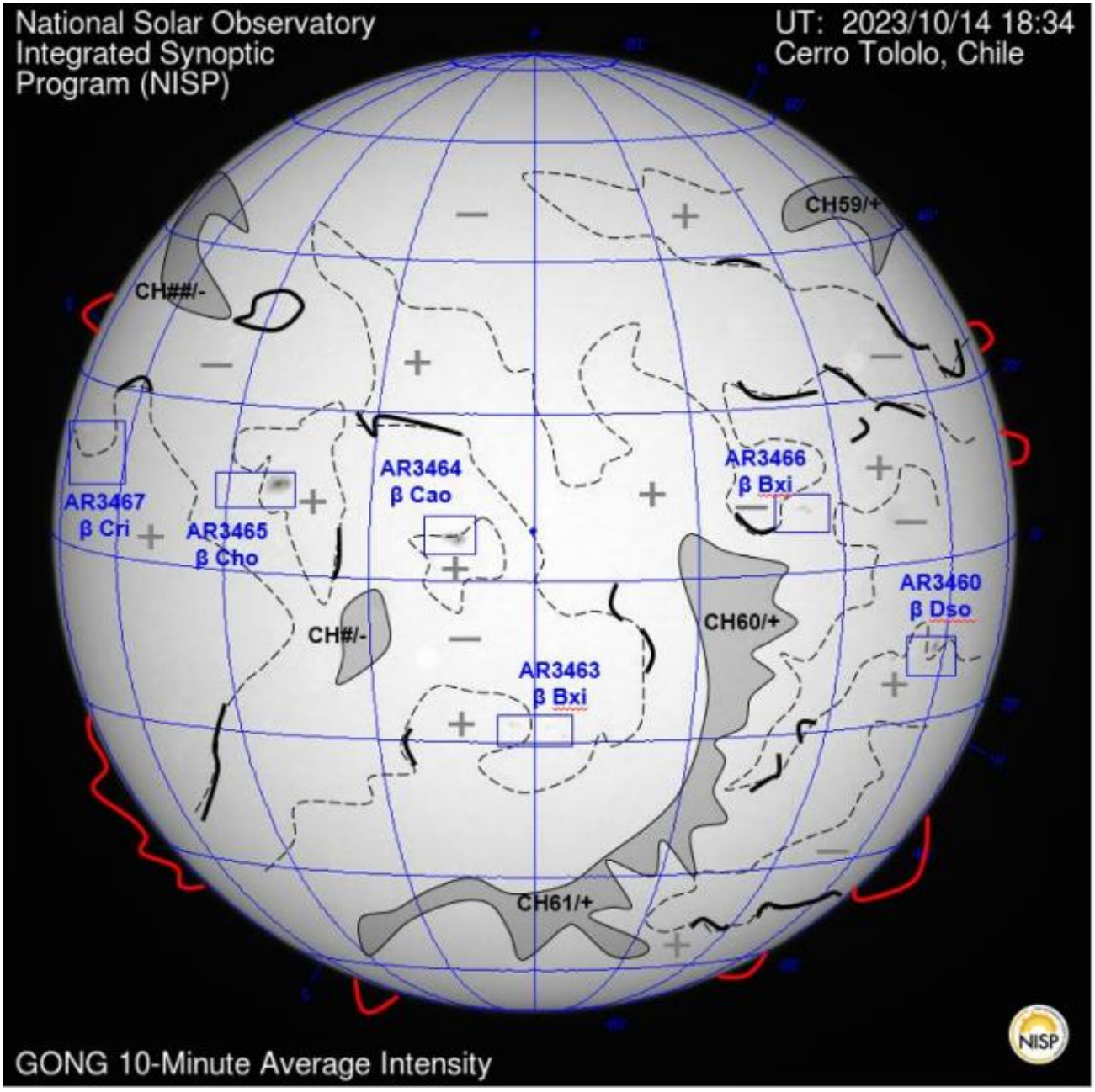
Figure 1. Solar Analysis Valid 14/1835UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The coronal hole forecast comprises two main features. Firstly, the current CH58-derived fast wind is considered likely to continue to wane over the course of the UTC weekend to leave fewer Unsettled intervals by the new working week. There is a little more uncertainty surrounding its successor, CH60/+, as MOSWOC Enlil appears to show any faster winds missing Earth, and because the persistence-based forecast was contaminated by CME effects on the last rotation. Partly because of its positive polarity, this feature offers a Chance of giving G1, with the peak blunted slightly by the risk potentially falling into the following UTC day as a Slight Chance.

There are now also up to two CMEs that feature in the coming four-day forecast: firstly, that from a corona-based dimming around N35W030 starting around 14/0340UTC. This has been modelled as delivering a possible glancing blow of Earth late in the UTC morning of Wednesday 18 October. Secondly, a CME from a dimming and observed filament channel in EUV from immediate north of AR3466 at 14/1240UTC, around N15W25. Given a similar inbound speed and emission longitude, this CME may add to or very closely follow the above CME glance, passing 1AU in the UTC morning of Wednesday 18 October, and perhaps giving a Chance of G1, although this is low confidence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	30	10	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1337	Partial	Filament	NW	448km/s	Late UTC morning Wed 18 Oct	Low confidence glance.
14/2152	Partial	Filament	NW	431km/s	Similar	Low confidence glance. Perhaps arriving with above.

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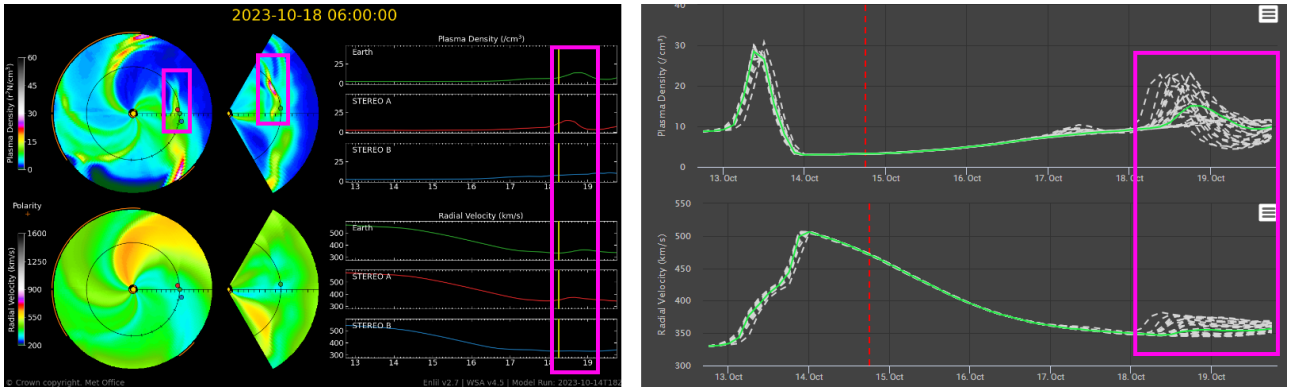
Figure 2: 14/1800UTC MOSWOC Enlil run and ensemble, showing range of perturbed solutions clustering around the middle of the UTC day of Wednesday 18 October. Although slower, the later of the two inbound CMEs is likely to face a lower denisty interplanetary medium and perhaps gain ground on its forebear. Both CMEs are low confidence, and although MOSWOC Enlil's recent poor representation of the current solar wind has improved, it is not felt to model CH60/+ adequately.



Radio Blackouts - X-Ray Flares:

There is a slightly rising Chance of M-class flares at first in the four-day period as a result of a spate of potential returning regions that lie around 100 East, with the risk therefore likely to have plateaued into the new working week. The risk of further M-class flares should then moderate slightly from midweek with the expected departure of one of the more complex and active sunspot groups of recent days, AR3460.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	No	30	40	40	30
Very Active	**R3 to R5 X Class**	No	1	5	5	1

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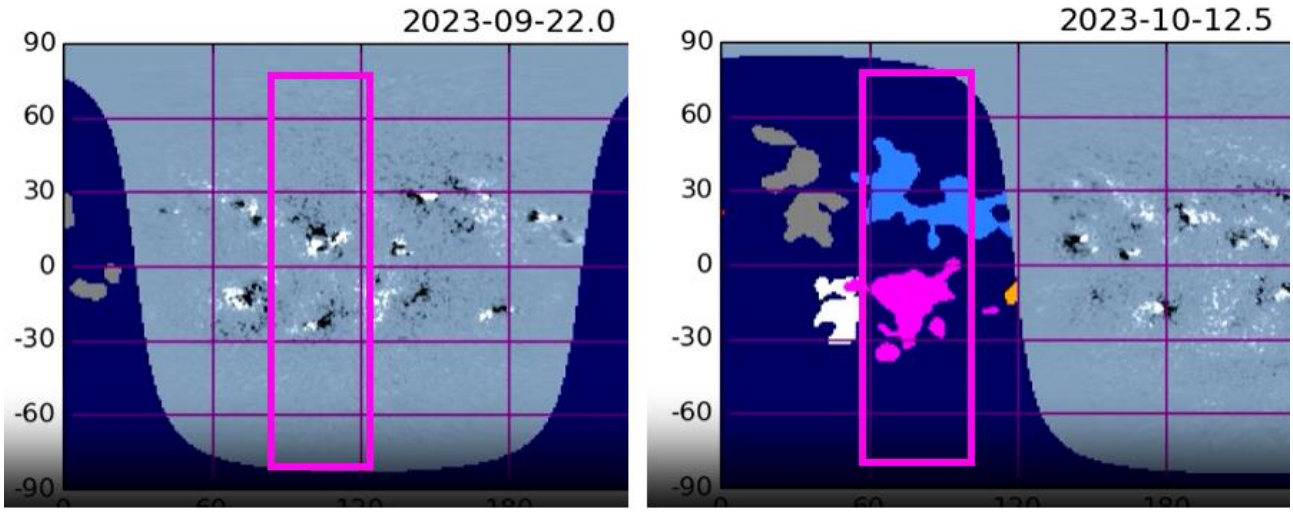
Figure 3: SDO HMIB and far side soundings for impending eastern limb regions – the HMIB dates from 22 Spetember when the returning Carringtons were directly on the Sun-Earth line, and the soundings date from 12 October before the signal appreciably weakened for being too near the limb.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at Background levels. There remains a Slight Chance of S1/Minor Solar Radiation Storms throughout the period, should any suitable larger flares occur.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux at GEO is likely to gradually restore into the new working week, bringing a Chance of 24-hour integrated Active fluence before the onset of the fast wind from CH60 later in the UTC day of Monday 16 October. The expected gap following geomagnetic activity from this fast wind and the potential for up to two following glances from CMEs on Wednesday 18 October is considered unlikely to offer sufficient respite for levels at GEO to recover before again being suppressed, although the slight rising trend in probabilities of Active fluence on Wednesday allows for the CMEs to miss or arrive later than billed. There is then the prospect of belated recovery in the second half of the UTC working week, i.e. just beyond the four-day forecast in the wake of any CME activity.

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	20	30	10	20
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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